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UNITED STATES PATENT APPLICATION FOR GRANT OF LETTERS PATENT

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INVENTORS

WALL STRUCTURE

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WALL STRUCTURE

FIELD OF THE INVENTION

The present invention relates to wall structures and more particularly to wall structures that may be fabricated in sections or modules.

BACKGROUND OF THE INVENTION

It is important in the design of wall structures to provide both lateral strength and lateral rigidity. Lateral strength is required to resist horizontal loads due to, for example, wind and earthquake forces. If the wall structure is properly designed and constructed, components of the wall will transfer these horizontal or shear forces to adjacent elements in the load path such as other wall components, floors or foundations.

Lateral rigidity is required to prevent the floors and roof from excessive side-sway. If the walls are sufficiently rigid, they will prevent floor and roof framing members from moving off their supports. In addition, buildings with sufficient lateral rigidity will suffer less non-structural damage and thereby avoid long-term degradation due to cracking and water infiltration.

It has long been common to brace walls or wall sections in buildings in order to provide some lateral strength and rigidity. Generally, this bracing has been provided through either sheathing secured to the outside of the wall or by straps or braces that extend at a diagonal along the outside of the wall. Such sheathing and diagonal bracing do transfer loads and tend to provide some measure of lateral strength and lateral rigidity in the wall. However, because of the location of the sheathing or the bracing, the loads transferred are transferred eccentrically. This, of course, results in the loads tending to twist the wall structure and its components, and consequently these loads are not directly and concentrically transferred to the foundation or other

termination points. In the end, such exterior sheathing and exterior bracing does not efficiently transfer shear loads.

Therefore, there has been and continues to be a need for a wall structure or wall module that is designed to efficiently provide both lateral strength and lateral rigidity through a concentric design.

SUMMARY OF THE INVENTION

The present invention relates to a wall structure, wall component or wall module that includes a pair of opposed members and a plurality of spaced apart studs connected between the opposed members. Openings are formed in the respective studs and at least one diagonal brace extends through the openings of the studs and is effectively connected at opposite ends to oppose corner areas of the wall structure.

In one embodiment, the diagonal bracing or support extends generally centrally through the wall structure. That is, the wall structure includes a pair of opposed sides and a generally central area disposed between the two opposed sides. The bracing includes a diagonal member such as a metal rod, shaft or cable that extends through the general central area or through a central plane of the wall structure or wall module. This generally centrally disposed brace or support is operative to carry and transfer loads concentrically from the point of the applied loads to one or more termination points.

In one particular embodiment of the present invention, the wall structure or wall module includes an upper member, a lower member, and a series of spaced apart studs connected between the upper and lower members. Openings are provided in a series of the studs. A diagonal brace extends through the openings within the studs and wherein the openings within the studs are spaced such that the diagonal brace or diagonal support structure can extend

between opposed corner areas of the wall structure or wall module. A pair of connectors are connected to opposite ends of the brace or support structure and extend therefrom to where the connectors connect to opposed corner areas of the wall structure.

In another particular embodiment of the present invention, the connectors just discussed are effectively connected at one end to the diagonal brace or support structure and at the other end the connector extends between one of the studs, or an end column, and either the upper or lower member of the wall structure. There the connector is fastened to the wall structure.

Other objects and advantages of the present invention will become apparent and obvious from a study of the following description and the accompanying drawings which are merely illustrative of such invention.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of the wall structure or wall module of the present invention.

Figure 2 is a side elevational view of the wall structure of the present invention.

Figure 3 is a fragmentary side elevational view of a corner portion of the wall structure.

Figure 3A is a view similar to figure 3, but which shows a modified connection between a corner connector and a brace.

Figure 4 is a view similar to figure 3, but with portions of the structure removed to better illustrate the invention.

Figure 5 is a side elevational view of the two plates that are utilized to form a connector in the wall structure.

Figure 6 is a side elevational view of the connector formed by the two plates shown in figure 5.

Figure 7 is a perspective view illustrating how the wall structure or wall module of the present invention could be incorporated into a multistory structure.

DESCRIPTION OF AN EXEMPLARY EMBODIMENT

With further reference to the drawings, the wall structure or wall module of the present invention is shown therein and indicated generally by the numeral 10. Wall structure 10 basically comprises an upper member 12 and a lower member 14. Members 12 and 14 may assume various configurations but in one embodiment, upper member 12 and lower member 14 would be of a generally U-shaped channel construction. In the case of the U-shaped channel construction, each member 12 and 14 would include a central or web portion and a pair of upturned, or downturned, as the case may be, flanges.

Secured between the upper member 12 and lower member 14 is a plurality of spaced apart studs 16. The studs are secured to both the upper and lower members 12 and 14. Studs 16 may be secured to the upper and lower members 12 and 14 in any number of ways. For example, fasteners such as screws can be extended through the flanges of the upper and lower members 12 and 14 into the respective studs. In addition, or in the alternative, 90° clips can be used to connect the respective studs to members 12 and 14.

Each stud 16 in the embodiment illustrated is of a channel construction and includes a web and a pair of opposed flanges. Certain studs 16 provided within the wall structure 10 are provided with openings 18 formed in the web portion of the studs. As will be appreciated from subsequent portions of this disclosure, the openings 18 are particularly spaced. For the most part, each of the studs 16 found in the wall structure 10 are of the same basic construction. However, in certain embodiments, the studs positioned on opposite ends of the wall structure 10 may be referred as columns and may be of a slightly different configuration and/or a heavier

gauge metal in the case of a metal wall structure. In fact, the ends or columns of the wall module may comprise multiple members.

As seen in Figure 2, the wall structure includes four corner areas 28. The corner areas 28 are denoted by the area enclosed by the dotted lines referred to by the numeral 28. Extending between opposed corner areas are a pair of braces or support members 20. It should be appreciated that it is not required in some wall structures to have both braces or support members 20. In some designs and for some particular applications, a single brace 20 would be sufficient. In any event, as seen in the drawings, each of the braces 20 extend between opposed corner areas 28 of the wall structure.

Braces 20 extend through the openings 18 formed in the studs 16. Consequently, the braces 20 extend through a central plane or a central area of the wall structure 10. Expressed in another way, the wall structure 10 includes opposed sides. Disposed between the opposed sides of the wall structure is a central area that basically lies between the opposed sides. The braces or support members 20 extend diagonally through this central area.

The braces or support members 20 can assume various configurations or designs. For example, the braces 20 may be in the form of shafts, rods, cables or other types of connecting or support structures. In the embodiment illustrated in the drawings, each brace 20 is in the form of a rod or shaft and includes a pair of sections 22 joined together by a threaded coupling or threaded sleeve 24. Formed about each end of each brace 20 is a threaded end 26. However, it may be preferred to provide each diagonal brace as a single member with the opposite ends having left and right hand threads. This means that the single member brace can be secured and tightened into two opposite connectors by turning the single member brace in a single direction.

As discussed above, the wall structure 10 includes four corner areas 28. Each brace 20 extends between opposed corner areas and is effectively connected to opposed corner areas. More particularly, a connector, indicated generally by the numeral 30, is connected to each end portion of each brace 20 and is in turn connected to a corner area 28 of the wall structure. Generally, each connector 30 includes a pair of sections, a first section and a second section. The first section of the connector 30 extends from the end portion of a respective brace 20 towards a connecting point in the wall structure. The second section of the connector 30 actually connects to a portion of the wall structure 10. In terms of the embodiment illustrated in figures 3 and 4, the first section of the connector comprises a generally triangular configuration. The second section of the connector 30 is that section that extends between a stud 16 or an end column and one of the members 12 and 14. As will be explained later, in the embodiment illustrated, the connector 30 comprises two plates that are mated together. In the first section, the plates are spaced apart, and as alluded to above, generally form the triangular configuration. The second section of the connector 30 is where the plates merge together and attach to the wall structure.

Thus, each connector 30 includes a pair of plates 32 and 34. Figure 5 shows each of the plates. First, with respect to plate 32, the same includes a cross member 32a and a flange 32b formed across the cross member 32a. Extending from the cross member is a leg 32c that bends and forms a tail 32d. A flange 32e is turned up along the tail 32d. Similarly, the second plate, plate 34, includes a cross member 34a and a flange 34b. Extending from the cross member 34a is a leg 34c and a tail 34d. Figure 6 shows plates 32 and 34 mated together. In particular, the second plate 34 is effectively inserted into plate 32 such that the legs 32c and 34c form the triangular configuration with the respective cross members 32a and 34a. Fasteners 33 extend

through the plates 32 and 34 to secure them together. More particularly, as viewed in figure 4, the fasteners 33 extend through flange 32b and through the leg 34c to effectively secure the two plates 32 and 34 together about the section of the connector 30 that extends around the brace or rod 22. As viewed in figure 4, the lower ends of the legs 32c and 34c form an apex where the tail portions 32d and 34d merge. Flange 32e forms the terminal end of the connector 30 and basically turns up and extends past the terminal edge of tail 34d.

The cross members 32a and 34b include an opening that enables an end portion of a respective brace 20 to be extended therethrough. The second or tail section of the connector 30 is designed to be inserted between a stud or end column 16 and one of the members 12 and 14. This is particularly illustrated in figure 4. The upper section of the connector 30 as viewed in figure 4 is connected to an end portion of the brace or rod 20 by a retainer or nut 52. A spacer bar 50 is interposed between the retainer 52 and the cross member 34a. A mounting insert 40 is inserted between the tail section of the connector 30 and the stud or end column 16. In particular, the mounting insert 40 assumes a generally L-shape and is secured by fasteners 42 to a flange or other portion of the stud or end column 16. Also, the flange 32e of plate 32 turns up adjacent the lower portion of the stud 16 and is fastened thereto by a screw or other type of fastener. The connector 30 is firmly secured to the wall structure 10 by a bolt or anchor bolt 54 that extends through openings formed in the tail portions 32d and 34d as well as through openings formed in the mounting insert 40 and the lower member 14.

The connector 30 shown herein is fabricated from sheet metal. It will be understood and appreciated by those skilled in the art that the connector 30 could be a single casting or made from a number of castings.

Figure 3A shows a modified form of connecting brace or member 20 to the opposed connectors 30. Here a spring 80 and a washer 81 are interdisposed between the spacer 50 and the nut 52. The strength, characteristics and size of spring 80 is selected so as to maintain the brace or member 20 in tension. For example, as the wall module 10 deforms or tends to deform one of the braces or member 20 may tend to be loosely connected between opposed connectors 30. As shown in figure 3A, the spring 80 will expand and effectively place the brace or member 20 in tension. When the wall module 10 assumes a no-load configuration or when the brace 20 is placed in tension, the spring 80 will assume a compressed configuration between the spacer 50 and the nut 52.

The wall structure 10 shown in figures 1 and 2 can be supported in a number of ways. As illustrated in figure 4, the wall structure 10 is supported on a sill plate 62 and an underlying foundation 60. Thus, the anchor bolt 54 is extended downwardly through both the sill plate 62 and into the foundation 60. Although a sill plate is shown herein, it will be appreciated that in commercial application or applications that are not based on wood construction, that a sill plate would not be required.

The respective connectors 30 and the braces 20 attached thereto can be securely stationed or fastened within the wall structure by tightening the retainer 52. By tightening the retainer 52, each connector 30 is pulled or urged in an axial direction along the rod or shaft 22 that forms the brace 20. This effectively places the rod or brace 20 in tension.

It is appreciated that the connector 30 such as shown in figures 3 and 4 would be disposed about the opposed corner areas 28 of the wall structure 10. Such a connector 30 would be anchored or secured within the wall structure in essentially the same manner as shown in figure 4. Connectors 30 disposed about the upper corner areas of the wall structure may be

anchored or secured into various overlying structure. However, still the second or tail section of the connectors 30 would generally be anchored the same way. That is, they would extend between the upper member 12 and a stud or end column 16. In this case, the anchor bolt 54 might extend upwardly into a stiffener, a roof joist or even a concrete floor section. Those skilled in the art will appreciate that the corner areas of the wall structure 10 can be secured or anchored to many different types of overhead or underlying building constructions. In multi-story construction, the wall modules 10 can be vertically aligned. In particular, individual wall modules 10 can sandwich intervening floor sections with the upper member 12 of one wall module lying underneath and aligned with the lower member 14 of another wall module.

The wall structure 10 of the present invention may be constructed of various components and materials. In one embodiment, it is contemplated that the wall structure would be of a basic metal construction. Figure 7 is a schematic illustration of how the wall structure 10 could typically be utilized in a multistory structure. Note that the wall structures or modules are vertically aligned from the foundation to the roof. Further note that the wall structures or modules 10 are ideally equal in width and height and are located symmetrically throughout the exterior walls of the building. In some cases, exterior walls cannot provide sufficient rigidity and strength throughout a building. In these cases, it may be important to provide that rigidity and strength through interior walls. Consequently, the wall structure or module 10 of the present invention can be incorporated into interior walls. In particular, the wall structures or modules can be used within interior walls when the allowable span to width ratio for the roof diaphragm is exceeded.

From the foregoing specification and discussion, it is appreciated that the wall structure or modules 10 of the present invention can be constructed of various heights and widths. Once

constructed in the fashion described, the wall structures or modules are inherently rigid and strong. Further, the wall structure or module 10 has the capacity to efficiently transfer shear loads to selected points in the wall structure such as to both upper and lower termination points. Thus, in the case of a shear load applied horizontally from the left, as viewed in figure 2, such shear loading will tend to result in the loads being transferred to the bottom corners of the wall structure 10. In this case, the lower right corner of the wall structure would be in compression while the lower left portion of the wall structure would be in tension. Also, because the braces or supports 20 are concentrically disposed within the wall structure itself, these shear forces or lateral loads are transferred in a concentric fashion throughout the wall structure. This avoids the drawbacks and problems that occur when the loads are transferred eccentrically.

The present invention may, of course, be carried out in other specific ways than those herein set forth without departing from the scope and the essential characteristics of the invention. The present embodiments are therefore to be construed in all aspects as illustrative and not restrictive and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.